Wim Klever

AXIOMS IN SPINOZA'S SCIENCE AND PHILOSOPHY OF SCIENCE

My objective in this article is the exact determination of the logical position and the epistemological role, which axioms have in Spinoza's scientific practice as well as in his philosophical reflection. Everybody is acquainted with the famous 'mos geometricus' as it is presented in the *PPC* and in the *Ethics*. In this favorite method of Spinoza the propositions of his system are demonstrated by means of the axioms, which are - together with the definitions - clearly formulated at the beginning of each main part of the work. But how are they affirmed? Are they undeniable and self-evident principles or does Spinoza introduce them as useful presuppositions or even as mere instrumental concepts whose only function it is to make possible the concatenation of the propositions? What is the difference between definitions and axioms? Is there really an important difference between axioms, common notions, postulates, lemmata, 'grondregulen' (KV 1/1), hypotheses, 'stellingen' (KV 2/26). Can we learn something from Balling's translation 'kundigheden' in his *Beginzelen der Wysbegeerte*? And what about a development in Spinoza's unconscious or conscious use of axioms in his procedure? Has he always been consistent in his differentation of the status of his concepts or can we trace some inaccuracy or looseness? What is the intention of his axiomatic method? One is overwhelmed by a lot of questions, if serious attention is given to the axioms, not only to the question of what things are handled as axioms but also to the questions, how, when and why they get their high axiomatic position and meaning.

The literature about our family of questions is scarce and insufficient. Only three of the 2200 publications on Spinoza's philosophy in the period 1971-1983 deal explicitly with his axiomatic method (cf. Van der Werf e.a. 1984).[1] The earlier bibliographies (Oko 1984; Wetlesen 1968, 1971[2]; Préposiet 1973) don't bring us much further. By far the most important contribution seems to be Hubbeling's *La méthode axiomatique de Spinoza et la définition du concept de Dieu (Hubbeling, 1977a; in Dutch 1978, in English 1977b).* Hubbeling objects to: a. the axiomatic (geometric) method is essential in the philosophy of Spinoza; b. in the wake of Euclid and Hobbes Spinoza's method is genetic-constructivistic-synthetic: an

object is understood by constructing or developing it from its elements and deducing it from its essential proporties (defended by Deleuze 1968, Gueroult 1968 and De Dijn 1973; 1976, with minor differences). Hubbeling does not deny that the axiomatic method is important in Spinoza's system nor that he got an impulse from reading Euclid, Descartes' and Hobbes' work. But the 'ordo (or: mos) geometricus' is neither a sufficient condition to reach the truth (witness the *PPC*) nor a necessary condition (witness the *Ep*, the *TTP* and *TP*). Spinoza's axiomatics is not purely formal as is usual in contemporary formal systems: he permanently reflects on what is said in the axioms, on their content. It is further imperfect (the rules of deduction are missing) and flexible. He does not mention previously all the axioms, which he makes use of, and is not consistent in indicating items as axioms or propositions.[2] Hubbeling provides a convincing illustration of this looseness by a comparison of the App. of the *KV* with Letter 2 and *Ethica* I. However, this last characteristic -he says - makes Spinoza's axiomatic method also **typically modern**. Principles are not considered to be axioms essentially, once and for all, but they are so named with a certain arbitrariness, depending on the circumstances of the demonstration. For Spinoza, **the choosing of the starting points is more a question of the efficiency of his system-building than of inherent necessity**.[3] Just as in modern conceptions formal systems are artificial, Spinoza's axiomatised system is not presented by him as the only possible picture of reality.[4]

Hubbeling's interpretation seems most adequate to Spinoza's work; in a certain sense Spinoza's method is opportunistic and pragmatic. This does not in all cases exclude the more essentialistic or ontological interpretation of Gueroult and De Dijn; his choosing of axioms is not blindly done but under the leadership of the intellectual light, which is common to him and his readers. Let us say that some of his axioms are universal intellectual principles, acknowledged by everybody (although not always in the same hierarchy and in the same formulation; this is, of course, also valid for Spinoza as can be proven from his definition of God); and that others are less central and fundamental, and therefore exchangeable and convertible for other items, which, now and then, can also be used as axioms.

The problem of Hubbeling's theory is, that it is not sufficiently demonstrated from Spinoza's text. His thesis can be made much

stronger by analysing the passages, in which Spinoza explicitly handles the question and by looking closely to his scientific practice. Providing it with this support is one aim of this article. Another purpose is the logical analysis and clarification of Spinoza's method against the background of contemporary philosophy of science (Carnap, Quine, Wittgenstein, Hempel, Oppenheim, Friedman)(cf.Klever 1984; 1985). Recent research fosters more and more the pragmatic and instrumentalistic interpretation of scientific laws, principles and concepts. The first and powerful application of this theory of science on Spinoza is supplied by J. Bennett in his impressive *A study of Spinoza 's ethics* (1985).[5]

Completely in line with Hubbeling's *approach (unknown to him),* Bennett takes Spinoza's axioms as **hypotheses**, which he needs to build his system and to connect his concepts: *the first bricks in an edifice which has to be tested as a whole* (p. 19). *So we, at least, must regard the axioms as something to be accepted provisionally in order to see how they work out in the sequel* (p. 18). *It is best to view the 'Ethics' as a* ***hypothetico-deductive*** *system - something that starts with general hypotheses, deduces consequences from them, and checks those against the data ... That is a widely accepted story about the abstract structure of scientific method* (p. 20). Yes, but until now not clearly recognised in Spinoza! Bennett is right, Spinoza's normal science in no way deviates from the usual practice to devise the fundamental layers or the general properties of nature from which the phenomena can be deduced, in order that a coherent and convincing model of the world is the result. Bennett quotes Spinoza's recapitulation of Descartes' physical method in *PPC* 3, which he seems also to make his own: *talia principia erunt excogitand ... ex quibus, tamquam seminibus quibusdam, et sidera, et terra et denique omnia, quae in hoc mundo aspectabili deprehendimus, oriri potuisse demonstremus.*

Eventually, when the conclusions are supported by the data of experience and the connection of our ideas becomes succesful, we will be able to see the axioms as self-evident, or at least stronger than they were before. Ceteris paribus and for the time being, the axioms are the easiest way to reflect and summarize the reality, just as the tourbillon-hypothesis was *commodissima* for Descartes. *Sic etiam nobis ad delineamenta naturae explicanda, hypothesin aliquam ad libitum assumere licet, modo ex ipsa omnia naturae Phaenomena per*

Mathematicas consequentias deducamus (ibid.).[6]

Extending a little bit Bennett 's quotation from *PPC* 3 and explaining its context, which implies that the axioms or principles of explanation can be chosen freely to a certain degree and that they are also called indiscriminately 'hypotheses', I have already started the main task of this paper, the accurate exploration of some texts. First of all we ought to **scrutinize Spinoza 's formulations**. A close reading of his wording gives a lot of information on his method. In the *KV* 1/1 (p. 16,l. 7) Spinoza demonstrates God 's existence a priori on the basis of three *grondregulen* (= fundamental rules). They are used in this chapter as axioms but none of them returns later, in the *Ethica*, as such. Spinoza simply says *wij stellen* (= we posit) by which he supposes that the reader agrees with him that a) the object of our knowing activity is infinite; b) there is a discrepancy between the finite intellect and the infinite object known; c) therefore the finite intellect must have been externally determined to its understanding of the infinite.

Whoever analyses the text of *KV* 1/1 and 1/2, must remark that Spinoza in his demonstrations makes use of a lot of other *grondregulen*, which he mentions clearly but does not explicitly account for. That man has an idea of God and does understand his properties, is made acceptable from **things which he knows and admits already** (*hieruit blykelyk, dat hy namelyk weet dat ...* = apparent from this that he knows namely that ...). These known items, which force him to accept Spinoza's thesis, are: d) that the infinite cannot be composed from finite parts (E 1P13); e) that one cannot have two infinites (cf. E 1P5, P8); f) that the one and unique Infinite is perfect and unchangeable. This is so because it is well known (*wel wetende, dat*), that g) nothing seeks its own destruction (p. 18, ll. 9-14) and h) all ruin comes from the outside (*Alle verderf is van buyten aankomende*(p. 18,l. 38). In the second chapter Spinoza argues for God 's essence as consisting of infinite properties on the ground of four propositions (= resp. E 1P8, P5, P6 and E 2P3), which are in their turn demonstrated with the help of inter alia: i) it is impossible that something comes from nothing (*van de Niet kan geen Iet voortkomen*, p. 21,l. 13); j) God's power is infinite (*uyt de oneyndelyke magt Gods*, p. 21,l. 35); k) the impossibility of a vacuum (*daar is geen ydel*, p. 25,l. 34). It is clear, that we are confronted here with a completely different arrangement of the stuff from that in the

later works of Spinoza. This is further confirmed by the fact that Spinoza uses the word 'grondregul' or 'regul' also explicitly for what he later (in E 2D2) calls a definition: *essentia ...: id, sine quo res, et vice versa quod sine re nec esse nec concipi potest* (p. 53,ll. 30-34). In a footnote (p. 81,28) he takes his later proposition (E 3P2) as a 'zetregul': *dat de wyze van de eene zelfstandigheid niet en kan overgaan in de ander zelfstandigheid*. The unusual word *zetregul* must be translated as *the rule we posit*.[7]

In his propedeutic work *TIE*, which seems to be older and more cartesian than the *KV* (cf. Mignini 1983, pp. 1-66), Spinoza **twice criticizes the axiomatic method** (cf. Klever 1986). In *TIE* §75 he says that we have to draw our science from nature as a whole and not from some abstract principles, *Naturam cum abstractis, quamvis sint vera axiomata, confundendo.* In *TIE* 93 he warns again against abstract axiomatic reasoning: *Unde nunquam nobis licebit ... ex abstractis aliquid concludere ... Nam ab axiomatis solis universalibus non potest intellectus ad singularia descendere, quandoquidem* ***axiomata ad infinita se extendunt***[8]*, nec intellectum magis ad unum quam ad aliud singulare contemplandum determinant.* This attitude against a modest exploitation of axioms is far away from his practice in the *KV* and his axiomatic professionalism in the *Ethics*. He is right, of course, in his nominalistic opposition to universality and arbitrariness; and we must agree with his theory about the infinite number of axioms, which can play a role. Nonetheless, all this cannot be a sufficient reason to reject the axiomatic procedure alltogether, and neither is it so for Spinoza himself. He pleads for arguing from adequate ideas, for the concatenation of things by means of *certissimas ideas, id est claras et distinctas* (TIE §80). Those clear ideas, the hinges of our scientific reasoning, are called ***hypotheses***, *quae a nobis clare intelliguntur* (TIE §52, note) or *quae fiunt ad certos motus explicandum, qui conveniunt cum caelorum phaenomenis* (TIE §57, note). Spinoza was wavering and not yet consistent in his logical remarks. At the same time, he calls 'hypotheses' both the ideas which are extremely clear and safe and also the ideas which are useful for physical explanation but may not be true (*quae tamen alia potest esse*). And why should we be dissuaded from practising axiomatic reasonings as hypothetical reasoning in the first or/and second sense? There was an inherent reason for the unfinished status of the *TIE*, according to the writers (Jelles and

Meyer) of the Praefatio of the *Opera Posthuma*!

In his *Ep* 2 (September 1661) Spinoza writes to his friend Oldenburg, that he sends him separately a number of propositions about Substance. And he adds the extremely important explication why he demonstrated them as a piece of mathematics: *Ut autem haec clare et breviter demonstrarem, nihil melius potui excogitare, nisi ut ea more geometrico probata examini tui ingenii subiicerem*. In *Ep* 1 and 2 it is supposed that Spinoza has already established his philosophy: the question is not at all how he discovered his ideas about God, the attributes and the modes of the Universe. Oldenburg was already acquainted with them but had many difficulties and doubts. To convince him of the truth of his philosophy, Spinoza now introduces a method of exposition, a **didactic procedure**. His geometrical manner is, according to his own words, not a method of discovery but one of transfer of his ideas to an audience. Other methods (e.g. an essayistic text or a conversational discussion) would take more time and remain vague.

But Spinoza was not successful. Oldenburg kept his doubts about at least a half of Spinoza's axioms. Some weeks later he asked him (Ep 3) an interesting question about the epistemological status of the axiomset: *an axiomata illa, quae mihi communicasti, habeas pro principiis indemonstrabilibus et naturae luce cognitis nullaque probatione egentibus.* What was self-evident for Spinoza, was not so for Oldenburg, with the result that the propositions built on it, crumbled also. For more details about Spinoza's geometrical enclosure and its relationship to the Appendix of the *KV* and to *Ethics*, part 1, I refer to Hubbeling's accurate reconstruction. His diagram shows that all the annex axioms got the lower status of a (deduced) proposition in the later *Ethics* 1.

Spinoza, however, did not budge an inch. He was vexed by the objection and refused further discussion. *Pergis tertio in ea, quae proposui, obiicere, quod axiomata non sunt inter notiones communes numeranda. Sed de hac re non disputo* (Ep 4). But at least we learn from Spinoza's reformulation of the question, that for him the axiomata are identical with the *notiones communes*, the concepts which are common to everybody, the ideas by which everybody's mind is illuminated. It had been his intention to put them, before the other notions (or propositions) on the top of his page, *quae proposui*. That

Oldenburg does not accept them, is curious; he has not given enough attention to the definition of substance, *ex qua haec omnia concluduntur*. Axioms - common notions - conclusions: these qualifications are not each other's opposite in Spinoza's epistemology. He illustrates for each of the four axioms, how it follows from the idea of substance. The difference between these (concluded) axioms and the propositions built on them is at most relative. The whole complex of items is a consequence of the one definition of God or Substance as *ens constans infinitis attributis* or *summe perfectum* or *quod in se est et per se concipitur*. This is the one, unique and fundamental idea which fills the human mind, the light which illuminates all relationships. Spinoza calls this a definition. And what do we read in the same letter? ...*veritatem huius axiomatis, scilicet, quod omnis definitio sive clara et distincta idea sit vera.* The lesson of this exploration is that in Spinoza's cupboard the definitions are on the highest shelf, on the second shelf the axioms, on the third and lowest shelf the propositions; but he is sometimes confused and puts his pottery in the wrong place; or does so in full consciousness, because the rearrangement looks better! The definition of God or the idea of the universe, however, always remains on the top; this is the idea, perfectly clear, from which the other ideas are produced, in a varying arrangement. Oldenburg was unable to discover the pattern of the deduction; it was for him *as a broom fallen into pieces* (Ep 5).

The circle of friends in Amsterdam is likewise embarrassed by Spinoza's *scripta* (Ep 8; mind the plural!); they don't catch exactly Spinoza's intention with his definitions and, after vainly consulting their library, beseach Spinoza for comment on the *distinctionem inter axiomata et definitiones* (Ep 8). In the answer to his dear friend Simon Joosten de Vries (Ep 9)[9] Spinoza first distinguishes between the definition which explains the essence of a thing and must be true, and on the other hand the definition which is merely a proposal, an arbitrary stipulation. The first type *debet ... **a propositione vel axiomata non differre, nisi quod illa tantum circa rerum rerumve affectionum essentias versatur, hoc vero latius, nempe ad aeternas veritates etiam se extendit***. Because it explains the thing truly *prout est extra intellectum*, this definition is properly speaking also a propositional truth, although a little bit more atomistic than the normal proposition or axioma (these two are equated here!). The

second type of definition *explicat rem prout a nobis concipitur vel concipi potest*. This definition only offers a possible conception of the thing, not an obligatory or true one; here the thing is not necessarily conceived *ut axioma sub ratione veri*. In this important and informative letter Spinoza explicitly establishes that there is no noticeable difference between the definition, *quae explicat rem prout est extra intellectum* (and such were Spinoza's definitions), the axiom and the proposition. From the combination of this statement with his earlier confession, that the geometrical manner is only for the sake of a clear and brief demonstration, we may conclude, that the organisation of the material *more geometrico* is not ontologically prefabricated but simply a **matter of strategics**. This pedagogical-strategical character of the geometrical structure in Spinoza's philosophy not only explains the often very different orderings of the material (as established by Hubbeling) but also his nonchalance or carelessness in terminology. Alternately some items are baptised as definition, axioma, proposition, *stelling*, *grondregul*, hypothesis or otherwise. A clear example of this terminological looseness is provided by the letters *Ep* 34 and 35 to the Amsterdam burgomaster and mathemacian Hudde in which Spinoza enumerates four axioms (partly identical with axioms of E 1) and calls them ***praesupposita*** (presuppositions, 2x) and ***hypotheses*** (also 2x). In *Ep* 35 he summarizes half *Ethica* 1 in six *proprietates* of the necessary Being, properties of the one idea of the Substance, which are partly identical with propositions of E 1 (e.g. 3 = E 1P8; 4 = E 1P13).

A thorough reflection on Spinoza's method, authorized moreover by himself, is presented by his friend Lodewijk Meyer in the Preface to *PPC*. We can be sure that the account of the geometrical method, which is so powerfully developed in this editorial, is a faithful explication of Spinoza's practice in the first drafts of the *Ethica* (cf. the correpondence just now discussed) and the result of Spinoza's own instructions. A preface by Meyer was the condition under which he was willing to give way to the pressure from his friends to publish Descartes' *Principia Philosophiae* 'more geometrico demonstrata' (v. Ep 13). The opening sentence of the preface says that everybody agrees, *that the method of the mathematicians for investigating and trasferring the sciences (in scientiis investigandis ac tradendis), by which namely conclusions are demonstrated from definitions, postulates and axioms, is the best and safest way to trace and teach the truth*

(optimam esse tutissimamque veritatis indagandae atque docendae viam). The excellency of the mathematical method is twofold: it has an **heuristic** value: it helps to find out the truth; and it has a **didactic** value; this way is advantageous for teaching activities, for the transfer of what one has found, as Spinoza already had declared in his first letter to Oldenburg (Ep 2). The reason for this sentence is, that things can only be drawn and deduced (and so proven) ***ex certo praecognitis***, from what is surely known previously. Without *certo praecognita*, without principles known and acknowledged by every participant in the discussion, demonstrations are impossible. Therefore it is advisable, to formulate these *certo praecognita* beforehand: *praestruenda erunt, tanquam stabile fundamentum*. As a firm starts with a working-capital, a demonstration starts, if it is to become effective, by *pre-supposing* or simply *pro-posing* the things we know already most safely, the socalled *kundigheden* (cf. note 9). They are contained and presented in our definitions (*apertissimae explicationes*) and our *postulates and axioms*: *Postulata autem et axiomata* ***seu communes animi notiones*** *adeo clarae atque perspicuae sunt enuntiationes, ut iis omnes, qui ipsa vocabula solummodo recto intellexerint, assensum negare nequaquam possint*. Also according to this utterance of Meyer, it makes no sense to differentiate sharply between definitions, axioms, postulates, common notions; all of them refer, nearly indiscriminately, to the fundamental layer of undeniable truths, on which the systematisation of our science has to be constructed. Together, the definitions and axioms (postulates) try to articulate the basic rules of our thought (*grondregulen*!). Meyer and Spinoza reject the opinion, *methodum istam mathematicis disciplinis esse peculiarem*. This method is universal, applicable in all sciences, especially in physics. Descartes had used the analytical method in his physics, the *Principia Philosophiae*, a work, which was greatly appreciated by Spinoza's friends and Spinoza himself. The friends were grateful that Spinoza was willing to systematize the first part of it (**similem redigeret in ordinem** ... *quo ab ovo res hoc modo disposita et melius intelligi et magis placere posset*) after he had already done so with the second part for Casuarius (***in syntheticum*** (ordinem) *redigere ac more geometris familiari demonstrare velle*). Again it becomes crystal clear, that Spinoza's geometrical method is nothing more than an ordering and organization of given material (Descartes' physics as contained in his

PP or his own *philosophy*) to make it more understandable. Nothing forces us to suppose that only one geometrical order is possible: it is quite natural that, on account of the innumerable axioms (cf. TIE §-63) different organizations are possible and can be successful.[10]

After this prolegomenon Spinoza starts his *PPC* with the nearly verbatim transcription of the ten definitions in Descartes' *Responsio ad secundas objectiones,*[11] omits Descartes' postulates (*quia ex iis nihil in sequentibus concludimus*),[12] then proposes three axioms (the first about the nature of a demonstration; the second (*tamquam axioma*) about Descartes' methodical doubt; the third about the mediate character of all knowledge which is not about our soul or body). After four propositions (of which the first *per se patet*!) there is another catalogue of axioms, this time *ex Cartesio deprompta* and intertwined with interesting remarks, as: *hoc axioma ex sola contemplatione nostrarum idearum ... innotescit* (after Ax4); *hoc unusquisque in se ... observat* (after Ax5); *hoc axioma nobis aeque perspicuum esse atque est 'ego sum cogitans' ... demonstravi* (after Ax7); *hoc axioma a praecedenti dependet* (after Ax8); *hoc axioma apud omnes ... in confesso est* (after Ax9). According to these explications Ballings' translations of axioms with *kundigheden* is quite obvious; Descartes writes: *axiomes ou notions communes*, a combination which is also used by Spinoza. Spinoza does not require the mutual independance of the axioms. Ax8 is demonstrated from Ax7, which in its turn was demonstrated in P4; Ax11 is, like a proposition, demonstrated with Ax7! This is Spinoza's practice; a difference between the status of axioms and of propositions is scarcely perceptible. For the demonstration of God's existence from our idea of God (P7) Spinoza inserts two sub-propositions or **lemmata**; he needs these **lemmata**, *ne rem indemonstratam relinquamus et omnem confusionem vitemus*; they are implications of the previously mentioned axioms, now made explicit.

In themselves the axiomata of PPC 1 as also the 21 axiomata of PPC 2 give us an informative view on Spinoza's state of mind, anno 1662. It is silly to treat them as merely Cartesian theses, as if Spinoza did not only partially extract them from the text of Descartes, as if Spinoza did not reformulate them, as if Spinoza did not consider them as self-evident, as his own axioms! Some of them are even unsurpassed expressions (e.g. PPC 2 Ax20) of his thought. The unfinished PPC 3 is already recapitulated in favour of Bennett's suggestion, that Spinoza's

method is justly qualified as hypothetical-deductive. In that context I have stressed the pragmatic and instrumentalistic character ('commodism'!) of Spinoza's and Descartes' procedure, but now I have to remark that this does not exclude but even implies, that we choose as our 'hypotheses' only those axioms, which are (as Spinoza underlines four times) ***valde simplicia et cognitu facillima***, comparable with the *clarissima* from which mathematicians start. A postulate which is not like that, brings us out of the frying-pan into the fire. Forced by Descartes' astronomy, especially his tourbillon-hypothesis, Spinoza reflects here on the postulatory character of hypotheses, which was, until than, not so much in the foreground. But it is, of course, an aspect of all axioms, that their truth-value is so high, because they are presupposed in all other, more specific propositions. Axioms (the word stems from the Greek $\alpha\chi\iota o\psi$) are those ideas, which have the highest worth and dignity in the field of our knowledge, while their relationships with other ideas (or phenomena) are most frequent, inevitable and undeniable.

The analysis of the *TTP* will bring us further in this direction, and will deepen our insight in the logical function of axioms. As is well known among Spinoza scholars, Spinoza elucidates the means by which the prophets try to persuade the people and to convince them of the elementary *dogmata fidei*. In ch. 5 (TTP 5/35) he contrasts these prophetic methods with the scientific method and develops in this way an interesting and revealing ***logic of science***. The first statement repeats Meyer's explication about the *certo praecognita* as the foundation of the demonstration. *Si quis hominibus aliquid suadere vel dissuadere vult quod per se notum non est (also demonstrations belong to this* **rhetorical** category!), *is, ut id iidem amplectantur, rem suam ex concessis deducere eosque experientia vel ratione convincere debet, nempe ex rebus, quas per sensus experti sunt in natura contingere, vel ex axiomatis intellectualibus per se notis.* A persuasion, also a scientific persuasion, can only be realised by making explicit the bond between the proposition which has to be proven and the things which are already admitted and known. Every person admits a lot of things (*concessa*); you convince him of something else, if you are able to deduce it from his (or her) *concessa*. That is the only way to do it, inside or outside science, in a sermon, a conversation or a presidential address. But there is a bifurcation. You can tie the *q.e.d.* to the *facts*

of daily sense experience or to the intellectual axioms which are self-evident (for the intellectual people who are able to reflect on Ahem!); the method of the prophets or demagogues is the first, the method of Spinoza and other scientists is the second.

The appeal to experiential data is, except in the case that they are clearly understood (*nisi experientia talis sit, ut clare et distincte intelligatur*) never so convincing and illuminating as the instruction with the help of intellectual axioms alone (*non tamen poterit ipsa intellectum aeque afficere eiusque nebulas dissipare, ac quum res docenda ex solis axiomatis intellectualibus, hoc est, ex sola virtute intellectus eiusque in percipiendo ordine deducitur* ...). If one looks sharply at this text, one discovers that the opposition between an appeal to the facts of sense experience and a demonstration from intellectual axioms is only superficial; the axiomatic procedure rests on experience which is clearly and distinctly understood; its axioms are in fact identical with the order in the perception, they represent an organisation of the visual world by the intellect.

However, the way to the heaven of science is long and difficult. *Verum quia ad res ex solis notionibus (!) intellectualibus deducendum longa perceptionum (!) concatenatio saepissime requiritur (...) ideo homines ab experientia doceri malunt, quam* ***omnes suas perceptiones ex paucis axiomatibus deducere et invicem concatenare.*** The last part of this sentence is worth its weight in gold for the undestanding of Spinoza's epistemology. The objective of science is: the concatenation of our perceptions (or, if one prefers this language, the phenomena). We try to bring them together and to integrate them in one model of the universe (or a section of it). There is, of course, no one-way-traffic: cross-sectional relationships are unavoidable. The way in which we can reach this endpoint is, the deduction of our perceptions (= phenomena) from general, all-pervasive characteristics or properties; or, in other words, the understanding of the diverse phenomena as appearances from fundamental axioms or laws. The *invicem concatenare* is an effect of the *ex paucis axiomatibus deducere*; and both concern the ***perceptiones***. In my opinion, this short explanation of Spinoza on the logic of science is an indisputable support of Bennett's imputation that this logic is hypothetico-deductive in the sense of the modern philosophy of science. This is still confirmed by *TTP* 5/37 where Spinoza writes, that one cannot convince a whole people by this

method; in this case one has to accommodate his reasons and definitions to the comprehension of the people: *non autem eas concatenare, neque definitiones, prout ad rationes melius concatenandum inserviunt, tradere*. Well, this is exactly what happens in Spinoza's own scientific work: definitions and axioms are selected according as they are helpful and instrumental to reach a coherent network of our ideas, an adequate picture of the world: Spinoza is not afraid of a purely instrumentalistic logic of science and confesses by this that the geometrical order to his *Ethics* is nothing more than a convenient instrument for the connection of his ideas about the universe. Naturally, the artificiality of this instrument does not mean that it is arbitrary![13]

This methodology, which explains how Spinoza works himself in the *Ethics*, is also exposed in ch. 7, where he gives his theory about the interpretation of the Scripture by the Scripture: *tota itaque Scripturae cognitio ab ipsa sola peti debet* (TTP 7/12). The method of hermeneutics is exactly the same as the method of physics, the science which interprets nature and can do so only with elements from nature itself, the phenomena. *Eam autem ... dico methodum interpretandi Scripturam* ***haud differre a methodo interpretandi naturam***, *sed cum ea prorsus convenire. Nam sicut methodus interpretandi naturam in hoc potissimum consistit,* ***in concinnanda scilicet historia naturae, ex qua, utpote ex certis datis, rerum naturalium definitiones concludimus***: *sic etiam, ad Scripturam interpretandam necesse est eius sinceram historiam adornare et ex ea tanquam ex certis datis et principiis mentem auctorum Scripturae legitimis consequentiis concludere* (TTP 7/6-7). In the natural science (to which Spinoza's *Ethics* belongs) we conceive and compose (*concinnare*)[14] a story about origin and development of nature in general, in order to deduce from that story and depth-structure, **as if** it is surely given, the comprehension (*definitiones*) of the individual things in nature. Science is, in the words of Carnap, *Aufbau der Welt*, a conceptual reconstruction, the sketch of a general model, on the basis of which the appearances (or: our perceptions) can be explained and become self-evident. First we move from experiential data to the overall-structure (the *historia naturae*), from which we then deduce (and so explain) the specific events. So what initially appears as a miracle, becomes afterwards quite natural and logical.

Natural science can be considered as an endeavour to systematize

one's available, experiental knowledge in such a manner, that one tries to formulate the most universal characteristics, which summarize everything that happens (the axioms) and then descends from these logically to the explanation of particulars. This is at least the way Spinoza sees and practises science: *Sicuti enim in scrutandis rebus naturalibus ante omnia conamur res maxime universales et toti naturae communes, videlicet motum et quietem, eorumque leges et regulas, quas natura semper observat et per quas continuo agit, et ex his gradatim ad alia minus universalia procedimus.* (TTP 7/27). The *Ethica* is the illustration 'par excellence' of this concisely formulated, hypothetico-deductive methodology. It is, in the opinion of Spinoza, not necessary, that the universal axioms, which together form the *historia naturae concinnata* are all equally clear and self-evident as the axioms of Euclid;[15] sometimes we cannot reach that high level of mathematical clearness but are still forced to postulate the axiomatic status for principles, because we need them and they are efficient suppositions for our work of interpretation and explanation. That is the reason why Spinoza said: *ex qua, utpote ex certis datis*: the axioms are often conventions that we cannot lack. We remember that in PPC 3 he spoke about hypotheses, which on account of their unavoidability were *commodissimae*. At the end of our ch. 7 in the *TTP* he hedges even more strongly, writing: *huius enim luminis natura et virtus in hoc potissimum consistit, quod res scilicet obscuras ex notis, aut tamquam notis datis, legitimis consequentiis deducat atque concludat* (TTP 7/70). We are forced to accept as an axiom not only what is self-evident (but isn't it so because it appears in everything?) but also what must be supposed if we are to understand everything: the known and the as-if-known.

In contrast to his other works, Spinoza does not give any methodological explication in his *Ethics*. This work only contains the results of his research of the properties of Nature (including man and his behaviour). The 'story of Nature' was reached before the writing of the *Ethics* started, in which Spinoza descends from the most universal and common properties of nature to its less universal occurences. Out of the infinite quantity of axioms and laws (cf. TIE), he has selected those, which look most evident, most fundamental and most suitable, to demonstrate the proposition and unveil the causal relationschips between the concrete things. The axiomatic form of his demonstration

is, although extremely serious and pushed very far, neither sustained perfectly nor always realised in the same, consistent way. It is the best possible result he could achieve, after various previous attempts (*KV*,*CM*, some letters, the proto-ethics). The axiomatic structure, which he gave to his system, is not essential to it: a complete alternative exposition is interwoven between the propositions, couched in the essayistic scholia, prefaces and appendices. One can reach a good understanding of all the main points of the *Ethics* by reading only these unformalised explanations.

His whole philosophy is axiomatically organised for the sake of a thorough demonstration of the all-pervasive *concatenatio* of things. He only once confirms this explicitly, namely in his introductory and excusatory remark, just before he provides a total different arrangement of the material of part 4: *Quae in hac parte de recta vivendi ratione tradidi, non sunt ita disposita, ut uno aspectu videri possint, sed disperse a me demonstrata sunt, prout scilicet unum ex alio facilius deducere potuerim. Eadem igitur hic recolligere et ad summa capita redigere proposui* (E 4A). His axiomatic dispostion of the material was, so he confesses, inspired by its suitability for demonstrative purposes, by its fitness to convince the reader. Because he in retrospect realises that the *concatenatio* is very long and difficult and cannot be understood in one view, he undertakes a less abstract and more readable report in short *capita*. Wolfson's assertion, that *the Ethics* is not a communication to the world *is completely off the mark*.[16] On the contrary, the reader-directed demonstration, i.e. the persuasive communication, was the main objective of his axiomatisation. He does not claim to have presented the unique or essential axiomatic structure or the one which is most succesfull; he only says, that he has done his best. And because he is not so very content with it, he takes the trouble to reformulate the material.

It is further interesting to notice that even in the so carefully written and rewritten *Ethics* Spinoza's terminology is elastic and fluctuating. He does not hesitate to identify axioms with common notions or with postulates. In E 2P40S1 axioms and common notions are equally considered *ratiocinii nostri fundamenta* and it is their instrumental value or use that is seen as the hallmark, which differentiates them.[17] Part 3 deviates because the definitions are not followed by axioms but by postulates. This change of terminology seems not to be important,

because Spinoza refers to the first postulate with the words: *hoc postulatum seu axioma*. Did we not conclude from the letters and from the *TTP* that axioms always have more or less the character of a postulate, of something, which is 'demanded' or 'required' to understand things in their *concatenatio*?

Until now I have tried to reconstruct Spinoza's axiomatic methodology from his practice and his own remarks, scattered all over his works. This philological research has not yet been done, so that I have filled up a gap. People have concentrated their attention too much on the *Ethics* and have overlooked the relevant texts elsewhere. This narrowness of vision seems to be the main reason for the traditional misunderstanding of the method, consisting of the thesis, that there is an *essential* relation between Spinoza's philosophy and **the or this** axiomatic structure. This conception was among others represented by J. Freudenthal (1927) and H. H. Joachim (1964). Other interpreters, who had an eye open for Spinoza's other works rejected the intrinsic connection; according to them the axiomatic order was simply a form of presentation or a literary genre. The already quoted Wolfson looked upon it as on a purely cosmetic device, a custom of the age, external to the content. According to E. Harris, *it is virtually certain that Spinoza regarded the geometrical order primarily as a method of exposition*. It was of paramount importance for him to use the most *objective and dispassionate method of exposition* which *he could devise for the presentation of his views* (Harris 1973, pp. 29s.) Th. C. Mark, who meticulously searched the existing literature, is wise in taking a standpoint between these extreme positions. Admitting on the one side that Spinoza is close to a **conventionalist** position, according to which *the designation of a given statement as an axiom is regarded as a matter of convenience or convention* and axioms are selected *with an eye to the ease with which desired conclusions can be drawn from them*, so that *in a given system* several different sets of axioms may be possible *with no sacrifice of logical rigor* (cf. Mark 1975-78; p. 274),he on the other hand refuses to deny the excellent logical and rhetorical qualities of the method (Klever 1984; 1985) and tends towards the idea, that a good scientist in one way or another axiomatizes his material. He is, however, wrong in his remark, that Spinoza nowhere presents the axiomatic method as a method of discovery (p. 263). In our quotation from his text we have demonstrated the opposite. The

axiomatization is for Spinoza also a way to trace and find the general features of reality. In this aspect he is still more modern than Mark supposes.

To round off my article, I just wish to explicate and articulate a little of this modern theory about the function and role of the axiomatization, which was constantly in the background of my reading of Spinoza's text and which I have elaborated elsewhere (Klever (1981) 1982). I must restrict myself to a few references to modern authors in theory of science.

Gilles-Gaston Granger has studied extensively the formal aspects of sciences in his *Pensée formelle et sciences de l'homme* (1967; 1975) in which he comes to the conclusion that ***le mouvement d'axiomatisation est donné dans la science même*** (p. 31). Sciences always construct a formal model (mostly also in a formal language), whose syntax has the potency to inform us about the objective relations between the phenomena (p. 37). The first step is the creation of a formalism, which is mainly the refining and fixation of the semantics of normal language in schematisms, geometrics and mathematics. But then the dynamics of explanation comes to the fore in the structuration of the semantic level. This 'axiomatization' is the work of reason, which tries to bring the semantic items into a coherent pattern and deduce them (and other, new items) from the fundamental substructure. *Axiomatiser c'est poser des principes constituant une base cohérente et suffisante de déduction pour toutes les propositions d'une théorie* (p. 160). It is by this process of unavoidable formalization and quite natural axiomatization that the meaning of the appearances is constituted and -provisionally - discovered. ***L'axiomatisation est constitutif.*** *Il n'est pas, bien entendu, chronologiquement premier, mais il correspond à une étape décisive de la prise de conscience et de la prise de possession de l'objet scientifique. Dans les étapes intermédiaires, la pratique scientifique fait état confusément de propriétés et de points de vue incoordonnés. La formulation axiomatique énonce ces présupposés et les constitue si possible en systèmes* (p. 165). By the axiomatization the first, superficial meaning of the phenomeny is destroyed, or - better - integrated in a concept, which is part of a broader or different context. *L'analyse axiomatique de la physique dénonce le faux privilège d'évidence des natures simples, et instaure le rêgne des évidences concertantes* (p. 167) In this way, the function of the axiomatization is

at the same time heuristic and justificatory. In a later work Granger seems to be still closer to Spinoza, where he writes: *La charge 'syntaxique' des règles de concaténation peut-elle être simplement considérée comme un encadrement auxiliaire, et relativement arbitraire, de l'expression? Ne représente-t-elle pas au contraire l'essentiel de l'information véhiculée?* (Granger 1979, p. 50).

The most influential philosopher of science today is Wittgenstein. What does he say about our subject? Wasn't he a crypto-spinozist? Without any doubt his thought is more concentrated on language and on the concept of rule than on that of axiom. And we cannot imagine a philosopher who with his informal procedure of expression is farther away from the rational and systematic exposition of Spinoza than Wittgenstein. Nevertheless we could better not neglect his intriguing remarks on the status and role of axioms in science. Let us take, e.g., the notes he wrote in the very last year of his life *On Certainty* (1972),[18] in which he states that science is marked by systematicity, in the sense that the degree of certainty is directly dependent on the degree in which our knowledge items are convergent and coherent. *All testing, all confirmation and disconfirmation of a hypothesis takes place already within a system. And this system is not a more or less arbitrary and doubtful point of departure for all our arguments: no, it belongs to the essence of what we call an argument. The system is ... the element in which arguments have their life* (no. 105). Our scientific system is not a homogeneous mass of propositions; they have a different truth-value according as they have a central or a marginal position. The propositions which have many or innumerable relations with other items in the field of our knowledge, constitute the logic; they form the rules, according to which we think and perceive, the 'rails' of our mind. They get their axiomatic position, because they are *verankert* in all my questions and answers and they *bewahrheiten sich* in all my ideas. In this way Wittgenstein accounts for the evidence of the axioms: ***Nicht einzelne Axiome leuchten mir ein, sondern ein System, worin sich Folgen und Prämissen gegenseitig stützen*** (Wittgenstein 1972, no. 142). He could not have given a better and more illustrative comment on Spinoza's philosophy. Axioms derive their high worth and logical normativity from their omnipresence and universal applicability, their *phantastische Anwendung*, as Wittgenstein calls it (Wittgenstein 1984a, p. 332 no. 675). In an other work,

Bermerkungen über die Grundlagen der Mathematik (1984b, pp. 223) his interpretation of the role of axioms is still more oriented on their pragmatic instrumentality: *Die Axiome eines mathematischen Axiomsystems sollen einleuchtend sein. Wie leuchten sie denn ein? Wie wenn ich sagte: So kann ich mir's am leichtesten vorstellen .... Was sagen wir, wenn uns ein Axiom dargeboten wird, z.B. das Parallelenaxiom? Hat Erfahrung uns gezeigt, daß es sich so verhält? Nun vielleicht, aber welche Erfahrung? ... Genug: wir nehmen ihn an. Wichtig ist nur, daß wir ihn gebrauchen ... Axiom ist etwas nicht dadurch, daß wir es als äußerst wahrscheinlich, ja als gewiß, anerkennen, sondern dadurch, daß wir ihm eine bestimmte Funktion zuerkennen und eine, die der des Erfahrungssatzes widerstreitet.* Their use and the fact that they are indispensable, makes them strong and altogether certain; it gives them an extra foot.

I have to stop my excursion into contemporary philosophy of science, although I should be happy to provide a further illustration of Spinoza's method with the theory of scientific explanation as it is found in the work of W.V.O. Quine (cf. Quine 1951; 1981). I hope that I have convinced the reader that Spinoza's axiomatic method, as it is explained by himself and practised, in no way diverges from modern conceptions of science. Spinoza is - not to repeat the constitutive elements - completely in line with the modern practice of axiomatic systems (as Hubbeling remarked) as well as with his methodological reflections on it. This last aspect of the question is now supported here by an analysis of the relevant texts, which were until now not taken into consideration, and by a short comparison with some dominant modern conceptions on this point.

NOTES

1 One of the three was Klever 1974, about which I now feel ashamed.

2 *Le système n'est pas rigide. Spinoza donne un système axiomatique informel* (Hubbeling 1977a, p. 36).

3 *Spinoza applique cette méthode d'une facon moderne, c'est-a-dire qu'il ne part pas d'axiomes qui sont donnés pour toujours, qui sont absolus, mais que selon lui il nous*

est permis de choisir nos axiomes... d'une facon assez arbitraire et de déduire de ces axiomes certains théorémes. Mais à une autre occasion il est parfaitement possible de choisir comme axiome ce que nous avons déduit la première fois comme théorème... Tout cela est en concordance avec les idées modernes sur la construction d'un sysème logique (ibid., p. 28).

4 *Welke wij nu kiezen als uitgangspunt voor ons axiomatisch systeem is dan meer een kwestie van efficiency van systeemopbouw dan dat hier sprake zou zijn van een noodwendige keuze* (Hubbeling 1978, pp. 21s.)
Il s'agit plutôt d'efficience de la construction de système que d'un choix inévitable, qui exclurait toute autre construction (Hubbeling 1977a, p. 29). Cf. Klever 1984; 1985a

5 V. the reviews by Klever 1985b and Hampshire 1984.

6 I have elaborated this instrumentalistic passage in Klever 1985a. One can also refer to the so-called *commodism* of Henri Poincaré; v. Poincaré 1968[2]. *Nous verrons aussi qu'il y a plusieurs sortes d'hypothèse, que les unes sont vérifiables et qu'une fois confirmées par l'expérience, elles deviennes des vérités fécondes; que les autres, sans pouvoir nous induire en erreur, peuvent nous être utiles en fixant notre pensé, que d'autres enfin ne sont des hypothèses qu'en apparence et se réduisent à des définitions ou des conventions déguisées ... Ces conventions sont l'oeuvre de la libre activité de notre esprit, qui, dans ce domaine ne reconnaît pas d'obstacle ... Mais, entendons-nous: ces décrets s'imposent à notre science ... Ils ne s'imposent pas à la nature ... L'expérience nous laisse notre libre choix, mais elle le guide en nous aidant à discerner le chemin le plus commode. La liberté n'est pas arbitraire* (p. 24).

7 In his *Appendix* Spinoza provides a list of seven 'axiomata', three of which return later in E 1 as propositions: pr. 1 (=ax. 1), pr. 2 (=ax. 4), pr. 3 (=ax. 5). Cf. Hubbeling 1977a.

8 In the *Index Rerum* of the *Opera Posthuma*, composed by his friends, who saw to the edition of his work, this explanation of the item 'axiomata' is the only one they mentioned. Cf. pp... of this volume.

9 The Dutch version of this letter in the *Nagelate Schriften* bears the title: *Van de Natuur der Bepaling en gemene kundigheit*. (About the nature of the definition and the common knowledge) 'Kundigheit' is an old Dutch word, referring to 'what is known'. 'Kunde' is cognate with 'kennis' (=knowledge) and is nowadays still used in composite words as 'geneeskunde' (=science of medicine). 'Kundigkeit' is clearly meant as translation for 'axiomata', which is, therefore, equivalent with 'what is known by everybody'. Cf. Spinoza 1977, pp. 109, 451 and 515.

10 In the continuation of his preface Meyer actually refers to the possibility that Spinoza could better have proven some axioms (*haec axiomata...concinnius nomine propositionum venire posse*) if he had had enough time, and that the demonstration

which he proposes, is not fully Cartesian *nec tantum in axiomatibus proponendis explicandisque, sed etiam in ipsis propositionibus caeterisque conclusionibus demonstrandis a Cartesio saepissime recedit atque apodeixi longe ab illius diversa utitur noster auctor*.

11 They were objected to by Mersenne. V. Descartes œuvres philosophiques 1967, Tome II, pp. 586ss.

12 Spinoza's reorganizing of Descartes' demonstration of God's existence purifies his text from superfluous elements.

13 Cf. TTP 13/2: a reference to ch. V in the words *qua scilicet non ex axiomatibus et definitionibus res deducit et concatenat*. The object of the concatenatio is called 'res' instead of 'reasons' or 'perceptions'. 'Definitions' is equivalent with 'axioms'.

14 *The sense of concinnare historiam is expressed among others by "gathering" (colligere), by "drawing under some headings" (ad summa capita redigere), by what is found in a certain field (reperiuntur)*. Zweerman 1974, p. 176.

15 *Euclidis propositions a quovis percipiuntur priusquam demonstrantur* in: TTP 7, p. 66, note.

16 Cf. also his remarks about *the cloistered atmosphere in which the 'Ethics' was conceived and written*, about Spinoza's *uncommunicative mind*. Wolfson 1973, pp. 18s.

17 The common notions refer to the universal properties, to what is common to everything. Cf. E 2P38 with C.

18 In my book *Dialectisch denken* (1981), ch. III (*Wiskunde en dialectiek*) I have developped the French context of Granger's epistemology: G. Bachelard, J. Cavaillès, A. Lautman, M. Serres. I recommend especially Caivaillès 1976, a small work that can be considered as a telescopical and microscopical view on Spinoza's axiomatics, although the same Spinoza is not mentioned (cf. G.G.Granger, Jean Cavaillès ou la montée vers Spinoza. *Les études philosophiques* 1947). See also Thom 1985, pp. 11-20.

19 *Der mathematische Satz steht auf vier Füßen, nicht auf dreien; er ist überstimmt*. Wittgenstein 1984b, p. 227, no. 7.

BIBLIOGRAPHY

Works of Spinoza

Spinoza: *Briefwisseling* Vertaald uit het latijn en uitgeg. naar de bronnen alsmede van een inleiding en van verklarende en tekstkritische aantekeningen voorzien door F. Akkerman, H.G. Hubbeling, A.G.

Westerbrink. Amsterdam : Wereldbibliotheek, 1977. (Werken van B. de Spinoza.)

Bennett, Jonathan: *A study of Spinoza's 'Ethics'*. Indianapolis, Ind. : Hackett, 1984.

Cavaillès, Jean: *Sur la logique et la théorie de la science*. Paris : Vrin, 1976[3].

Deleuze, Gilles: *Spinoza et le problème de l'expression*. Paris : Presses Universitaires de France, 1970.

Descartes, René: *Œuvres philosophiques*. Ed. par F. Alquié. Paris 1963, 1967, 1973.

Dijn, Herman de: "Spinozas geometrische methode van denken". *Tijdschrift voor Filosofie35 (1973), pp. 707-765.*

Dijn, Herman de: "Opnieuw over de geometrische methode van Spinoza". *Algemeen Nederlands tijdschrift voor wijsbegeerte* 70 (1978), pp. 29-38.

Freudenthal, Jacob: *Spinoza Leben und Lehre*. Heidelberg e.a. : Carl Winter e.a., 1927 (Bibliotheca Spinozana ; 5.) (2 vols. in 1.)

Granger, Gilles-Gaston: *Pensée formelle et sciences de l'homme*. Paris : Aubier, 1967; 1975[2]. English translation: *Formal thought & the science of man*. Dordrecht : Reidel, 1983.

Granger, Gilles-Gaston: *Langages et épistémologie*. Paris : Klincksieck, 1979.

Hampshire, Stuart: Rev. of Bennett, *A study of Spinoza's 'Ethics'*. *Times Literary Supplement* 16-11-1984.

Harris, Errol E.: *Salvation from despair : A reappraisal of Spinoza's philosophy*. The Hague : Nijhoff, 1973.

Hubbeling, Hubertus Gesinus: "La méthode axiomatique de Spinoza et la définition du concept de Dieu". *Raison présent* No. 43 (1977), pp. 25-36. Quoted as: 1977a.

Hubbeling, Hubertus Gesinus: "The development of Spinoza's axiomatic (geometric) method : The reconstructed geometric proof of the second letter of Spinoza's correspondence and its relation to earlier and later versions". *Revue internationale de philosophie* 31 (1977), pp. 53-68.

Hubbeling, Hubertus Gesinus: "Spinoza's axiomatische methode en zijn definitie van God". *Algemeen Nederlands tijdschrift voor wijsbegeerte 70 (1978), pp. 38-46.*

Joachim, H.: *A study of the 'Ethics' of Spinoza*. New York : Russel & Russel, 1964. (Earlier prints: Oxford : Clarendon Press, 1901; 1958.)

Klever, Wim N.A.: *Dialektiek contra axiomatiek : Een confrontatie tussen Spinoza en Hegel onder methodologisch opzicht*. Leiden : Brill, 1974.

Klever, Wim N.A.: *Dialectisch denken*. Bussum : Het Wereldvenster, 1981.

Klever, Wim N.A. "De wijskundige rede". *Tijdschrift voor filosofie* 46 (1984), pp. 611-642.

Klever, Wim N.A.: "Friedmans radicale instrumentalisme, why not?" Maandschrift Economie 49 (1985), pp. 19-25. Quoted as: 1985a.

Klever, Wim N.A.: Rev. of Bennet, *A Study of Spinoza's 'Ethics'*. *Studia Spinozana* 1 (1985), pp. 408-413 (410-413). Quoted as: 1985b.

Klever, Wim N.A.: "Circulaire bewysvoering". Tydschrift voor Filosofie 44 (1982), pp. 630-640.

Mark, Thomas Carson: "Ordine geometrico demonstrata : Spinoza's use of the geometric method". *Review of metaphysics* 29 (1975-76), pp. 263-286.

Mignini, Filippo: *Introduzione a Spinoza*. Bari : Edizioni Laterza, 1983. (I Filosofi ; 37.)

Oko, Adolphe S.: *A Spinoza bibliography*. Boston, Mass. : K. G. Hall & Co, 1964.

Poincaret, Henri: *La science et l'hypothèse*. Paris : Flammarion, 1968[2].

Préposet, Jean: *Bibliographie spinoziste...* Préface de Gilbert Varet. Paris : Belles Lettres, 1973.

Quine, Willard van Orman: "Two dogmas of empiricism." *The philosophical review* 60 (1951), reprinted in *Analyticity* ed. by J.F. Harris a.o., Chicago : Quadrangle Books, 1970, pp. 23-53.

Quine, Willard von Orman: *Theories and things*. Cambridge, Mass. : Beleknapp Press, 1981.

Thom, R.: "La méthode expérimentable : un mythe des épistémologues." *Le débat* 34 (1985), pp. 11-20.

Werf, Theo van der / Siebrand, Heine / Westerveen, Coen: *A Spinoza bibliography 1971-1983*. Leiden : Brill, 1984. (Mededelingen van wege het Spinozahuis : 46.)

Wetlesen, Jon: *A Spinoza bibliography, particulary on the period*

1940-1967. Oslo : Univ. vorlaget, 1971. 2nd rev. ed., arranged as a supplementary volume to A.S.: Oko's Spinoza bibliography. Oslo ; Bergen ; Troms∅ : Univ. forlaget, 1971.

Wittgenstein, Ludwig: *On certainty*. Ed. by G.E.M. Anscombe and G.H. van Wright. New York : Harper Torchbooks, 1972².

Wittgenstein, Ludwig: *Bemerkungen über die Philosophie der Psychologie. Letzte Schriften über die Philosophie der Psychologie*. Hg. v. G.E.M. Anscombe, G.H. von Wright u. H. Nyman. Frankfurt a.M. : Suhrkamp, 1984. (Ludwig Wittgenstein: Werkausgabe in 8 Bdn. ; 7.) (suhrkamp taschenbuch wissenschaft ; 507.) Quoted as: 1984a.

Wittgenstein, Ludwig: *Bemrkungen über die Grundlagen der der Mathematik*. Hg. v. G.E.M. Ambscome, Rush Rhees u. H.H. von Wright. Frankfurt a.M. : Suhrkamp, 1984. (Ludwig Wittgenstein: Werkausgabe in 8 Bdn. ; 6.) (suhrkamp taschenbuch wissenschaft; 506.) Quoted as : 1984b.

Wolfson, Harry Austryn: "Behind the geometrical method." In: *Spinoza : A collection of critical essays*, Marjorie Grene (ed.), Garden City, New York : Anchor/Doubleday, 1973 (2nd ed. Notre Dame : UP, 1979), pp. 3-24. (From: Wolfson, Harry Austryn: *The philosophy of Spinoza*, Cambridge, Mass. : Harvard UP, 1934, vol. 1, pp. 3-31.)

Zweerman, Theo: "The method in Spinoza's Tractatus de intellectus emendatione : Some remarks on this problem inspired by the Tractatus theologico-politicus and by Epistola 37."In: *Spinoza on knowing, being and freedom : Proceedings of the Spinoza symposium at the international school of philosophy in the Netherlands (Leusden, september 1973)*, J.G. van der Bend (ed.), Assen : Van Gorcum, 1974, pp. 172-183.

ZUSAMMENFASSUNG

Die Absicht des Artikels ist eine genaue Bestimmung der Bedeutung der Axiome in Spinozas Wissenschaft und in seiner Wissenschaftsphilosophie. Die Untersuchung will zugleich linguistisch, praktisch und logisch sein und auf diese Weise von der Wechselwirkung der Spinozistischen Praxis und Reflexion profitieren. Aus dem Wortgebrauch und der Argumentationsweise, sowohl in den essayistischen Werken (KV, TTP, Ep) als auch in den geometrisch verfaßten Schriften, und aus den wenigen meta-methodischen Bemerkungen kann man schließen, daß am meisten für eine völlig **pragmatische c.q. instrumentalistische** Interpretation der Axiome zu sprechen scheint. Damit werden die Thesen von Hubbeling (über den modernen Charakter der formalen Methode, als orientiert an der Zweckmäßigkeit) und von Bennet (über den **hypothetisch**-deduktiven Charakter des Spinozistischen Systems) vom Text her untermauert und gerechtfertigt. Im letzten Abschnitt wird gezeigt, daß Spinozas Wissenschaftspraxis und Wissenschaftslogik eine gewisse Fortsetzung findet in den Gedanken von Granger und Wittgenstein über die Rolle der Axiomatisierung in der Sozialwissenschaft und der Mathematik. Spinoza würde bereit sein, Wittgensteins Formulierung zu übernehmen: *So kann ich mir 's am leichtesten vorstellen*.